

**SPECIFICATION**

BE IT KNOWN, that I, Herman K. Dupre, a citizen of the United States of America, residing at c/o Seven Springs, Champion, PA 15622, have invented certain new and useful improvements in:

**SNOW MAKING APPARATUS**

of which the following is a specification.

# **SNOW MAKING APPARATUS**

## **CROSS REFERENCE**

This application is a continuation-in-part of U.S. Application No. 10/218,801, filed August 14, 2002.

## **BACKGROUND OF THE INVENTION**

This invention relates to snow making apparatus, and more particularly, to snow making apparatus of the type which utilizes, at least in part, internal mixing of air and water under pressure.

Many different devices have been devised and used for “artificially” producing snow or for producing “man-made” snow. Such devices are utilized at ski resorts to supplement the supply of natural snow on ski trails. Whether the snow making apparatus is situated at ground level or atop a support tower, they are generally referred to as “snow guns” in the industry and they all typically produce snow by projecting a mixture of air and water under pressure in the form of a fine atomized water spray into the surrounding sub-freezing ambient atmosphere. The snow guns are of basically two types, one wherein the air and water are internally mixed before spraying into the ambient atmosphere and a second wherein the air and water are externally mixed in the ambient atmosphere such that water spray droplets are projected into a stream of cold air under pressure. The present

invention relates to the type of snow making apparatus or snow gun which utilizes external mixing techniques with all the advantages of internal mixing. Internal mixing and external mixing each have their own advantages and disadvantages.

Internal mixing of the air and water under pressure allows for excellent control of the atomization process. The resulting plume of atomized water which is formed in the exterior atmosphere is made up of uniformly sized well frozen nuclei. To the contrary, a wide variety of droplet sizes are found in the nucleating plume generated through external mixing of air and water. In addition, with external mixing of air and water from separate streams under pressure, high winds tend to deflect the air and “strip” the air from making full and efficient contact with the water spray in such external mixing designs. Accordingly, internal mixing tends to be more efficient.

Through the use of internal mixing designs, nuclei or ice seed crystals are able to be formed at a higher ambient temperature than is possible through the use of external mixing. The result is better quality snow at equal or higher temperatures.

However, a number of problems have been encountered in the industry with internal mixing snow guns or snow making apparatus. Freeze-up of the nozzle in some prior art internal mixing snow guns tends to be more likely than incurred with external mixing apparatus which is properly configured. With many existing internal mixing designs, freeze-up is common as moving ice crystals block the nozzle and the mixing or nucleation nozzle must be constantly heated by one means or another in order to keep the nucleation nozzle operating. Heating the nucleation nozzle

is a major disadvantage or limitation because not only does it increase the manufacturing cost and operating complexity of the unit, but significantly limits the product's field and areas of use. In addition, ski resorts or ski areas do not normally have electricity on the ski slopes which is available for use with the operation of snow guns.

5                   In addition, internal mixing snow guns also tend to be easily clogged, and they also are designed whereby one cannot operate the snow gun with water only when the ambient sub-freezing temperatures are adequately low, since when one turns off or significantly lowers the pressure of the air supply the water will back down the air supply tube and freeze in the air supply line. For example, it is apparent that this problem exists with the design illustrated in U.S. Patent  
10   No. 5,083,707.

It is therefore an object of the present invention to eliminate or at least greatly reduce the aforementioned disadvantages of internal mixing snow guns and to further provide an external mixing design wherein water may be directed out of the snow gun without the assistance of compressed air if so desired without unfavorable consequences and to also produce more and better  
15   quality snow at higher temperatures with less consumption of compressed air and water.

### **SUMMARY OF THE INVENTION**

The snow making apparatus of the present invention utilizes water and air under pressure to artificially produce snow and is generally comprised of a metal snow gun housing having

independent air and water chambers therein for supplying an air-water under pressure to at least one, and preferably multiple, nozzles in the housing for spraying air and water externally to produce snow in sub-freezing ambient atmosphere. The supplied air pressure is normally at least 75 psi and the supplied water pressure is normally at least 150 psi. At least one, and preferably multiple, nucleating  
5 nozzles are provided in the snow gun housing and include a nozzle housing having an air chamber therein for each nucleating nozzle. Each air chamber has at least one aperture through its side walls whereby one or more apertures register with the air chamber within the snow gun housing for access of air under pressure therethrough into the air chamber. The air chamber has an external end and an internal end wherein a water aperture is provided on the internal end with a forward end of the water  
10 aperture axially exposed to the interior of the mixing chamber. The rearward end of the water aperture is exposed to the water chamber within the snow gun housing for projecting a jet stream of water under pressure through the water aperture and on into the air chamber. An exterior nozzle is provided on the nozzle housing at the external end of the air chamber and has a nozzle aperture therethrough which is axially aligned with the water aperture. This exterior nozzle aperture exits  
15 from the snow gun housing to ambient atmosphere. A removable filter closes off the rearward end of the water aperture for filtering the water supplied from the water chamber and an access plug is provided in the snow gun housing and positioned for access to the filter for servicing or removal.

This nucleating nozzle combination directs the water jet stream from the water aperture axially through the larger exterior nozzle aperture without engaging the sides of the aperture  
20 which creates extremely fine homogeneous nucleation of the water exiting the exterior nozzle aperture with the air under pressure into ambient atmosphere for the manufacture of quality snow.

In addition, this fine nucleated spray is also effectively utilized to atomize additional water sprays provided on the external areas of the snow gun housing in order to provide good quality snow at less expense due to the reduction of air and water required normally to manufacture quality snow, and further due to the fact that this fine atomization is effective to convert more of the water to snow.

5                    In general use, the nucleating nozzle of the present invention will normally be used in combination with at least one additional primary water nozzle in the snow gun housing which is positioned for spraying water from the water chamber to the ambient atmosphere for interaction with spray from the nucleating exterior nozzle for extremely fine atomization of the primary water spray.

                    The internal nozzle housing is economically manufactured of a single metal block  
10   including a plurality, such as three, of the nucleating nozzles therein with the rearward ends of these water apertures exiting to a common single rearward end cavity which is closed off by a filter to prevent clogging of the fine water jet apertures. The exterior nozzles are also removable so that they may be replaced, repaired or unclogged. Under general operating conditions, the filter might typically be comprised of a metallic mesh having filter apertures of no more than .010 inches, which  
15   is also the diameter of the nucleating water jet stream apertures. This assures that the small water apertures will not become clogged. The filter is threadably received in and secured to the nozzle housing.

                    In this specific given example, the water jet aperture was selected to be .010 inches in diameter and the exterior nozzle aperture might typically be selected to be approximately .060

inches in diameter. This arrangement permits the sharp water jet stream to exit through the exterior nozzle aperture without engaging sides thereof and to thereby intimately intermix with air under pressure from the air chamber as they exit the exterior nozzle aperture to create an external plume of very finely nucleated water. Thus even if the air supply is turned down or off the water under  
5 pressure will not back down the air supply line feeding the air chamber.

The metal block which is utilized for the nucleating nozzle housing is preferably provided with passages through the block in those areas where other passages are not required in order to provide maximum circulation of water through such passages and about the nucleating nozzle housing and the interior of the snow gun housing to prevent freeze-up by continually  
10 permitting the warm water to thoroughly circulate.

The snow gun housing may take on different applications or forms, such as a ground level gun or it may comprise the upper end of a snow making tower. In the configuration of a tower, the access plug is positioned in the top end of the tower for access to the filter.

The apparatus of the present invention thus provides a filter which is automatically  
15 cleaned upon shutdown of the snow gun by shutting down the water supply first. In this event, the remaining air under pressure in the mixing chamber is blown back through the water aperture and purges debris off of the exterior of the filter.

When the water to the snow gun tower is initially turned on, air is trapped at the top of the snow tower and must be evacuated, otherwise freeze-up will occur at the top of the snow gun and the snow making apparatus will become ineffective. With the design of the present invention, including the filter at the top of the snow tower, when the high pressure water is turned on it is at a  
5 much higher pressure than the air trapped within the top of the tower, and due to this the trapped air will become purged from the top of the tower and exit through the filter along with the water under pressure entering the filter.

With the design of the present invention, as the water jet exits through the exterior nozzle, it is surrounded by air under pressure which causes extremely fine and uniform nucleation  
10 of the water as it exits to ambient. This water jet also gives mass to the nucleated plume and projects the plume further from the snow gun than is possible with prior art exterior mixing nozzles and thus causes better intermixing with other added external water sprays and also the plume is less affected on windy days by being misdirected with high winds.

The exterior nozzle aperture is preferably a round hole. As the air expands when it  
15 exits the exterior nozzle aperture, it expands immediately and intimately shreds the water jet causing ultra fine and homogeneous nucleation. This immediate expansion of the air as it exits also provides maximum cooling of the nucleated plume.

The nucleating nozzle combination of the present invention permits the use of less air and water to manufacture more quality snow at higher ambient temperatures. For example, prior

art snow towers designed by the present inventor utilize 50 gallons of water per minute with the consumption of 50 cfm of air at an ambient temperature of 26 degrees F maximum. The apparatus of the present invention provides an extra fine air-water nucleation stream for external interaction with primary water sprays wherein the water spray apertures for the extra primary water sprays may  
5 be reduced from 1/8 inch water nozzle apertures to 1/16 inch apertures. Accordingly, the apparatus of the present invention can produce more good quality snow using only 15 cfm of air while using only 30 gallons of water per minute at a higher external ambient temperature of 28 degrees F.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

Other objects and advantages appear hereinafter in the following description and  
10 claims. The accompanying drawings show, for the purpose of exemplification, without limiting the scope of the invention or appended claims, certain practical embodiments of the present invention wherein:

FIG. 1 is a view in partial mid vertical cross section of the snow making apparatus of the present invention as seen along section lines I-I of FIG. 2; and

15 FIG. 2 is a plan view in horizontal cross section of the apparatus shown in FIG. 1 as seen along section line II-II.

## **DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT**

The snow making apparatus 10 of the present invention utilizes air and water under pressure to artificially produce snow and it is comprised of a metal snow gun housing 11 having independent air and water chambers 12 and 13 supplying air and water under pressure respectively  
5 to external nozzles 14 in housing 11 for spraying an air-water mixture externally of housing 11 to produce snow in sub-freezing ambient atmosphere.

Three nucleating nozzles 15 are provided and include a block nozzle housing 16 in which the nucleating nozzles are formed. Nozzle housing 16 is disposed in snow gun housing 11 and is provided with three passages 17 through sidewalls of each air chamber 18 which register the  
10 air chambers 18 with air supply passages 12 for access of air under pressure through passages 17 from pipe 19 into air chambers 18. Air chambers 18 have an external end 20 and an internal end 21. Water jet apertures 22 are provided on the internal ends 21 with forward ends thereof axially exposed to the interior of respective air chambers 18. The rearward ends of water apertures 22 are exposed to snow gun housing water chamber 13 via cavity 23 and filter 24 for projecting water jet streams  
15 under pressure through apertures 22 into the respective air chambers 18.

Exterior nozzles 14 are threadably received into housing 16 at the external ends 20 of air chambers 18 and each has a nozzle aperture 25 therethrough which is axially aligned with water jet stream apertures 22 so that the water jet stream exiting into air chambers 18 from water

apertures 22 will be directed on through exterior nozzle apertures 25 without engaging the sides thereof and will not be directed or deflected downwardly through passages 17 into the air supply.

Filter 24 is a removable filter closing off the rearward end cavity 23 of water apertures 22 for filtering water supplied from the water chamber 13. Access plug 26 in snow gun housing 11 is positioned at the top of the gun 11 for access to and removal of filter 24 which is threadably received into nucleating nozzle housing 16.

The filter 24 is a conventional filter which may be found on the market and which is normally used for air compressors and it is comprised of a metallic or bronze compressed mesh having filter apertures of no more than .010 inches which will prevent any plugging of water jet stream apertures 22. The outside filter surface of filter 24 will self-clean when the snow gun 11 is shut down by closing off the water supply first. In this event it can be seen that air under pressure within passage 17 will exit through water nozzle apertures 22 in reverse and blow debris off the outer surface of filter 24.

In this representation, the snow gun 11 is shown in the form of the upper end of a snow making tower and the water jet stream apertures 22 are approximately .010 inches in diameter and the exterior nozzle spray apertures 25 are approximately .060 inches in diameter. Passages 27 are provided through block 16 for circulating water from water chamber 13 therethrough to keep the warm water moving and to prevent freeze-up at the top of the snow gun housing 11.